

ON BRONCHOSCOPY.¹

WITH REPORT OF A CASE IN WHICH A FOREIGN BODY WAS REMOVED FROM
THE RIGHT LOWER LOBE OF A LUNG THROUGH A BRONCHOSCOPE.

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THE direct examination of the larynx and trachea are rather rarely used and recent methods. Bronchoscopy is the most recent addition to this kind of direct inspection, and it appears to be very little known as yet. For information and instruction in using the instruments, I am indebted to the courtesy of Dr. Wild, of Zürich, Switzerland, who was formerly an assistant of Professor Killian. These methods are probably generally considered as belonging to the practice of specialists. I do not, however, think that, for instance, inferior bronchoscopy ought to be necessarily considered as such. Bronchoscopy is an outgrowth from œsophagoscopy, which was first executed by Kussmaul, and of late more brought *en vogue* by Mikulicz and others. Kirstein first showed direct laryngoscopy, from which originated direct tracheoscopy. The farthest step was finally taken by Killian, of Freiburg in Germany, with his bronchoscopy. With straight tubes of different calibers and lengths he showed that the air-passages could be explored far beyond the bifurcation of the trachea. He advises the use of the little electric head-light of Kirstein with an attached reflecting mirror, through the centre of which the surgeon looks. Especially where demonstration is desired, an electric light fixed to the bronchoscopic tube (Kasper's handle) is very useful. This special apparatus is not absolutely necessary, since, in the case which I am about to report, I had to make the greater part of the examination with a common search-light and a common head-mirror. While it was not as convenient, the light was

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good and sufficient. The bronchoscopic tubes are connected with a solid handle, with which we can use quite a little force in directing the bronchoscope into the desired direction. Some guide tubes, in case we want to change the tube for a longer or shorter one of the same caliber, are added. Sponge-holders, a fine suction tube, some hooks, and several kinds of forceps constitute the armamentarium. The instruments are as well adapted for œsophagoscopy. The examination can be done either directly through the mouth and larynx (the tubes being up to fifty centimetres long) or through a tracheotomy wound (inferior bronchoscopy). The head has to be thrown far backward, so as to allow of introduction parallel to the axis of the body.

The history of the case, which was kindly referred to me by Dr. William Richeson, of St. Paul, is in brief as follows: Five weeks ago a woman, forty-eight years of age, during a coughing spell, while eating soup, felt a bit of bone get into the windpipe. There has been coughing ever since and expectoration. The temperature, which had been taken the three days previous to my first visit (October 22, 1903), was slightly subfebrile, reaching 100.2° F. As I was going out of town for three days, I advised for the start inhalations with Tinct. benzoin comp., 50.0; creosote and turpentine ãã 25.0. These inhalations, as recommended a few years ago in the Johns Hopkins Hospital bulletins, I use prophylactically and therapeutically in all kinds of surgical proceedings in the air-passages, and they have given me very great satisfaction.

On October 26 I ordered the patient to the hospital for surgical measures for the following reasons: First. There had been some fever, now $99\frac{1}{6}^{\circ}$ F. Second. Severe coughing spells were frequent. Third. Such a case is always to be considered as a grave one on account of the secondary complications.

On the day of admission, an attempt was made to make a bronchoscopic examination through mouth and larynx after the application of 20 per cent. cocaine in 1 to 10,000 adrenalin. On two trials to insert the tube through the larynx alarming choking spells occurred, which continued for a little while even after the removal of the tube. A large goitre which she had was judged to

be partly the cause of the difficulty. The goitre presented two large lateral lobes of medium consistency, which joined over the trachea. It is just such lateral lobes which are prone to produce tracheostenosis, by side pressure on the tracheal cartilage rings, which are open behind.

A strumectomy was decided upon as a preliminary operation. This was done on October 27. A horizontal incision was made and the median portions of the two lobes were removed. There were numerous ligatures needed, but the loss of blood was very slight. Finally, the trachea was laid bare for a distance of about four centimetres. The wound was closed to a small central opening, through which an iodoform gauze strip was introduced and laid over the trachea, so as to have it handy for further measures. The wound healed very nicely up to the drainage opening. The drainage was removed after four days, and the patient was allowed to leave the hospital on November 2, six days after the operation. It was judged better to postpone the opening of the trachea until November 10 (two weeks after the strumectomy).

November 10, in the presence of Drs. G. Schwyzer, E. F. Geer, A. R. Hall, and Moynihan, the granulating wound was somewhat enlarged in the old scar line, and some granulation tissue was removed until the trachea was felt plainly under the finger and probe. The trachea was then opened by an incision, the lower end of which was about three centimetres above the manubrium sterni. This opening of the trachea was made at least two centimetres long, so as to allow the insertion of the bronchoscope without difficulty and without marked kinking of the trachea. All this was done without even local anaesthesia; but as severe coughing started when the trachea was cut into, we at once anaesthetized it with the above-mentioned cocaine adrenalin solution, the utmost care being exercised to prevent cocaine poisoning. There was not more than a small quantity at hand, and only a part of it was used. There were no signs of any general effect at any time. I judged the adrenalin would be useful, first, since by the extreme contraction of the blood-vessels caused by it the mucosa would be less voluminous; second, the hæmorrhage which would come from the injury of pushing the bronchoscopic tube up and down in the different parts of the lungs would be much reduced, and therefore much sponging would be saved and also much coughing; third, since the combination of the

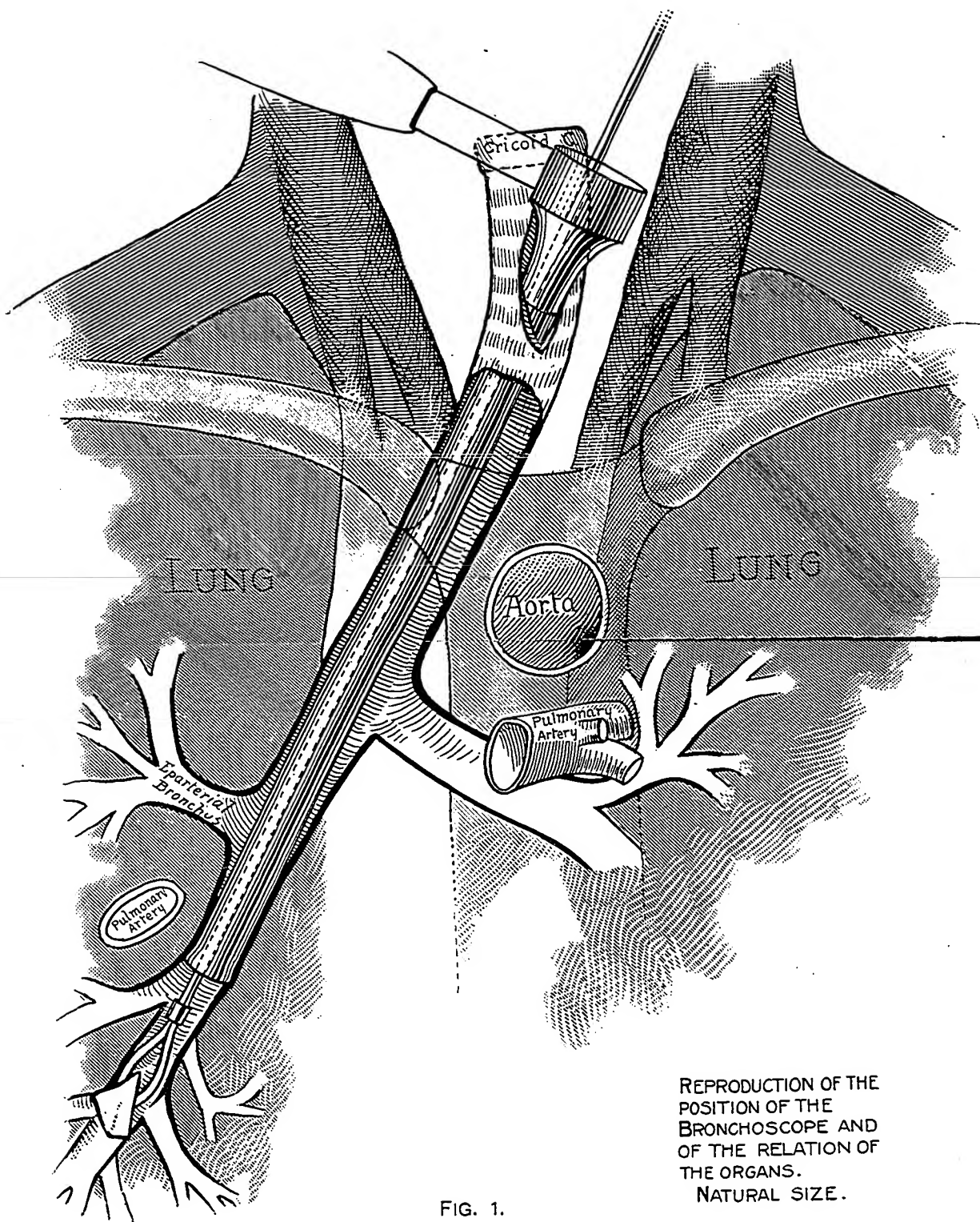


FIG. 1.

REPRODUCTION OF THE
POSITION OF THE
BRONCHOSCOPE AND
OF THE RELATION OF
THE ORGANS.

NATURAL SIZE.

adrenalin would prolong the action of the cocaine and cause it to be less rapidly absorbed. This would reduce the toxic effect, which is an important factor when the whole tracheo-bronchial system has to be explored. It may be mentioned that we did not use cocaine away down in the bronchi except when a coughing spell began to hinder the manipulations.

The patient was removed into a dark room and was examined in a horizontal position, the head thrown far back by a round pillow under the shoulders. The exploration of the bronchi was done only with the help of the mentioned local anæsthetic; and it was very fortunate that a general narcosis was not necessary, because the whole performance took from 9.40 to 11.55 A.M. (A part of this time was lost in often allowing the patient to rest, though usually with the tube in the bronchus.) The tube employed measured fifteen centimetres up to the thicker region of the handle. Its lumen had the caliber of a bougie No. 24. The tube was inserted down into the trachea and the bifurcation was made visible. The two principal bronchi were seen and found free. I entered the right bronchus, but could not see things plainly. Then I went back into the left bronchus. At its entrance the mucosa was somewhat hæmorrhagic, apparently slightly injured by the tube. I found the left bronchus in all its length free, and showing besides a pale color some anthracotic discoloration in small areas. The secondary bronchi were plainly seen as dividing off, but no trace of a foreign body or any suspicious change in the appearance of the bronchi could be detected.

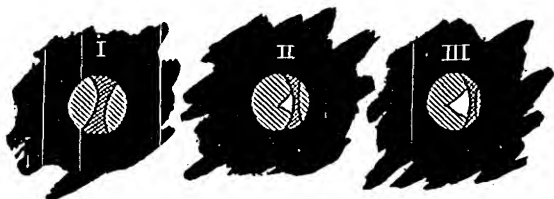
There was much lively and even violent pulsation going on around the bronchi. This everlasting motion and activity in the chest was very impressive, and made us use the utmost care in handling the instruments. The arch of the aorta rides on the left bronchus, and the pulmonary arteries are in even closer proximity to the bronchi. These large vessels, practically at their origin from the pumping heart, explain this fact sufficiently. The motion is most pronounced on the left bronchus, and was no longer noticed when we had entered far down in the right bronchial tree. The more we reach the periphery with our bronchoscope, the more, however, comes respiratory motion into play. The breathing was not giving any difficulty. From my drawing (Fig. 1), in which I gave as nearly as possible the natural size of the bronchi, one can see that there was room for breathing on

the sides of the bronchoscope. There was, of course, lively breathing going on through the tube. Killian has shown that, when the one bronchus is entirely put out of function on account of the tube, the respiration does not become dyspnoëic. The exchange of air goes on sufficiently through the bronchoscope and the one lung under exploration.

I had satisfied myself that the foreign body (if there really was one in the lungs) was not in the left bronchi of first and (most probably) second order. By this time I had exchanged the special electric-light apparatus (the Casper handle with its light and the little Kirstein head-light) for a common laryngoscopic head-mirror with a strong electric search-light at some distance in front of me. This had become necessary on account of some trouble with the battery. The light was now brighter, but the search through the long tube was exasperating at times on account of slime and blood and coughing spells. I then began the thorough search of the right lung. The main bronchus was free but reddened, and contained much mucopurulent secretion. This change was already an important guide. The bronchus was followed to the origin of the secondary bronchi. After much searching and sponging and following the right bronchus to its end as far as the tube would reach, I thought I saw in the depth a small whitish spot. After repeated trials, I recognized it as a foreign body, and thought it to be the sharp point of a *bone*. The tube had been entered six inches (fifteen centimetres) from the tracheal opening downward. The tracheal opening was three centimetres above the incisura sterni. When the tube was allowed to lie as it would naturally, merely two bronchial openings were seen (Fig. 2, I). When it was tilted with its lower end to the right in a moderate way, Fig. II was seen. In the picture it may appear that the tube was now more to the left than in Fig. I. It must, however, be taken into consideration that the bronchi are not solidly fixed in their course and position. In reality, the lower end of the bronchoscope was more to the right, as I had inserted the tube somewhat deeper, and felt it enter more towards the left one of these two bronchial branches, which had a straighter course downward. Then, when I had caught part of this bifurcation with the lower end of the bronchoscope, I pressed to the right so as to see straighter down into this lower bronchial branch. Now, the little triangular white body could be seen at some distance in this lower branch. When

a maximum of force was used in pressing the lower end of the bronchoscope to the right, this white triangle became as large as Fig. III shows.

FIG. 2.



The bronchoscopic images.

I may add here, that it is surprising how one can move the exploring tube into the different bronchi. They give way to pressure, and take a straight course over the inserted instrument because they are in the loose, soft lung tissue, which is ready to yield. When we reach a division of a bronchus, tilting of the bronchoscope will allow us the entrance into the desired side; and as soon as we have entered the channel, the tube may be pushed forward, if it is done under constant control of the eye. The drawing shows how even the trachea in our case had to be moved far to the right. On one occasion I managed to introduce a small hook beyond the bone. When I, however, pulled at it, it seemed caught, and the mucosa appeared to lay itself in folds in front of the bone, which pushed it forward from behind. I did not dare to pull too hard, because I was afraid of forcing the sharp-edged bone into a more firmly fixed crosswise position; and when I could not free it with a reasonable amount of traction, I was glad when I had the little hook free again. It was not until some time after I had seen the white body that I finally succeeded in grasping it safely with a forceps. The bone was too large to be brought through the small bronchoscope, therefore I withdrew the tube together with the forceps, and fortunately the bone in its grasp. A small strip of mucosa came along also; however, there was no marked bleeding.

The bronchoscope had not reached the immediate neighborhood of the bone. The latter was about three centimetres beyond the tube. This was part of the difficulty. The accompanying photograph (Fig. 3) gives the exact position of the instrument

when inserted down to the foreign body. The bone was therefore removed from a point eighteen centimetres below the tracheal opening, or fifteen centimetres below the upper border of the manubrium sterni. The measurements were taken immediately after the extraction of the bone, and they were controlled by Drs. Hall and Moynihan.

It may be mentioned that the patient, who received once during the operation a hypodermic of strychnine, stood well the tedious performance, and, though she complained now and then (when asked) of being tired, claimed even towards the end to feel "good." There were at no time severe pains; but now and then a harder coughing spell was produced, when a new area of the lungs was entered into, which had not yet been sufficiently cocaineized.

It is interesting to note how the pains of the patient, who located the trouble to the left of the heart apex region, were misleading. The patient distinctly claimed that the trouble was located on the left side. I had, however, told her and the doctors present that I considered the foreign body to be on the right side, having heard moist râles of medium size over the right lower outer anterior region, and there only. This corresponded with the location of the bone. The piece being somewhat like a sharp-edged triangular pyramid explains the fact that breathing was not abolished over this lung area. The air found some opening on the sides of the bone. I had made no note about reduction in the breathing sounds.

It may be objected that we undertook all these manœuvres and even the goitre operation though we had no absolutely sure proof that there was a foreign body present, and that we did this notwithstanding the patient had somewhat improved after the goitre operation. There had, however, occurred a severe coughing spell the evening before the bronchoscopic search; and it is just this more or less constant coughing, if it first started after a mishap in the deglutition, which is significant, especially when combined with now and then very severe coughing spells, though an adequate reason for it does not otherwise exist. Principally on this symptom I based the positive diagnosis. The patient had been well up to the point when she got something into the "wrong pipe." It happens comparatively so often while eating soup, because small pieces of bone are often there unexpectedly, and a



FIG. 3.—Photograph made eight days after removal of the foreign body, showing the direction and extent of insertion of the bronchoscope, and the forceps.

motion of inspiration is made when eating this liquid from the spoon. The history was typical in our case. Fever had set in. The case ought to have been skiagraphed before the operation, but this had to be omitted for other reasons.

The after-history is very simple. The wound was covered with gauze. Every two hours the patient received the same inhalations as before the operation.

On the afternoon of the day of the operation the patient coughed considerably and had a bloody sputum. The temperature, however, remained below 100° F., and on the following days at the highest reached 99° F.

On the day after the operation there were no râles to be heard over any part of the lungs, except at voluntary coughing, transmitted from the trachea. On the next day (November 12) the patient claimed to feel much better than before the last operation. Very little coughing; much less than before the bone was removed. Patient felt quite strong; sat up in a chair. No air passing through the tracheal incision.

On November 13, three days after the operation, the patient left the hospital. On November 18 patient came to my office, where the adjoined photographic picture (Fig. 3) was taken. Condition very good.

Of the literature pertaining to foreign bodies impacted in the air-passages, I should like to first mention the standard work of Hoffmann, in Nothnagel's "*Specielle Pathologie und Therapie*," 1897. In this treatise Hoffmann gathers 160 cases (operated and not operated), only taking into consideration the sufficiently clearly described ones. In forty-five of the cases operative measures were used, principally tracheotomy; in single cases, however, opening of a bronchiectasis or opening of an abscess cavity. Hoffmann classifies the foreign bodies in the following way:

First. Bodies apt to be coughed out on account of their weight and smooth surfaces (pieces of money, glass pearls, etc.), ten cases, with nine cures, of which six had a tracheotomy. In three cases the favorable result was not dependent on the tracheotomy.

The second group consists of hard and irregular pointed

bodies (pins and pieces of bone), which could not be expected to be coughed out. Of these he gathered fifty-one cases, among which are thirty-eight non-surgical cases with twenty-one deaths to seventeen cures, while among the thirteen operated cases there were only three deaths.

A third separate group contains ears of grain. These give very poor chances for a spontaneous expectoration. In none of the sixteen cases was the foreign body coughed out soon after its entrance. In four cases it was expectorated after a long interval (fifty days to many years); four others of the sixteen died, and eight were cured after formation of abscesses, which perforated through the chest wall.

Another, fourth, group contains the fruit kernels. Of these were, non-surgical, twenty-four cases with eight cures and sixteen deaths. Operated, thirteen cases with seven cures and six deaths. Considering separately kernels apt to swell hygroscopically, Hoffmann finds non-surgical, seventeen cases, with five cures and twelve deaths; operated ones, eleven cases, of which only three died.

A fifth group contains all the other cases of very different kinds. Hoffmann declares that surgical procedure is for the large majority of the cases the proper one, but he condemns working with hard instruments without the control of the eye. Hofmeister (*"Handbuch der practischen Chirurgie,"* Bergmann, Bruns, and Mikulicz) also highly recommends an active but careful surgical procedure, and especially if the case is a recent one, where other simpler methods have not yielded a result. Only in a case of a foreign body of small size, which entered far down into the bronchi, where it cannot be reached from above, may an expectant treatment be allowed.

Kredel (*Mittheilgn. aus d. Grenzgeb. der Med. und Chir.*, 1903, Band xi, Heft 1) reports some interesting cases, and emphasizes careful surgical measures in cases of impaction in the bronchi, even if the foreign body cannot be seen, as in small children. A flexible wire loop gave him good service.

Kredel, the latest one of these mentioned writers, thinks it doubtful that the extraction under the guidance of the mirror

should be easier; the technique, of course, being more complicated, if simultaneously a mirror and the instrument for extraction have to be handled. He appears not to have personally used Killian's instruments. He says that, as much as the results of the bronchoscopy are praiseworthy, it will hardly become popular, because there is too much special training needed and too many special instruments, etc. Furthermore, he thinks that it is doubtful whether bronchoscopic measures are less dangerous (with or without tracheotomy) than the other procedures thus far resorted to. I must somewhat differ with Kredel in these latter points. First of all as to the special training needed. While such operative measures are not within the reach of every general practitioner, a surgeon, who can do a satisfactory cystoscopic examination in male patients or even only in women, is in my estimation entitled to handle Killian's tubes for the inferior bronchoscopy. The superior methods, that is the use of straight tubes per vias naturales into larynx and trachea, are hard ordeals for the patients in most cases. The inferior bronchoscopy is, however, not as heroic a measure as it might appear.

What concerns the second objection of Kredel, the need of special instruments, I can answer that the special apparatus for illumination may, if necessary, be dispensed with, and there remain only as really needed some straight tubes and spongeholders. The hooks and forceps are as well needed for extraction with as without bronchoscopy.

That the whole performance is less dangerous, and more satisfactory with the bronchoscope than without, will probably be admitted by every one who has used it once. It is my aim in this report to emphasize the practical value of Killian's thought.

Bronchoscopy, where it is feasible, is certainly a splendid help. And where should it not be feasible, when the trachea is opened? Even in small children it must be possible to a good measure.

Where a foreign body is so far down in the lungs, as it was in our case, I cannot see how any other procedure could be

compared with this method. Where it is possible, bronchoscopic examination ought to precede the removal of foreign bodies from the bronchi, and the manipulations and the extraction ought to be done under the guidance of this instrument, as in such way unnecessary injuries will best be avoided. In the most difficult cases the bronchoscope will be the only means of accomplishing a successful extraction.

Three days after reading this paper, I was called by Dr. Plondke, of St. Paul, to see a girl of four years and seven months who had a kernel of corn in the bronchus for five weeks. The right lung had been giving hardly any breath sounds. At my examination, there was, however, breathing on both sides, and nearly equally loud. Over both lungs there were very numerous râles, most pronounced on the left side. The breathing was characteristic. It was dyspnoëic, interrupted by much difficult coughing. The finger-nails were bluish. There was orthopnoëa; the little child did not dare to lie down for fear of more difficulty in breathing. While the inspiration was comparatively rapid, and, though somewhat difficult, freer than the expiration, the latter was much labored and very often cut short, so that it appeared to me as if closed by a ball-valve. The voice was hoarse, and together with a croupy cough pointed to a difficulty at the glottis. Temperature, 100° F. I diagnosed a foreign body, which had moved from the bronchus into the trachea and was in expiration forming a ball-valve under the glottis.

I operated as soon as the preparations would allow. The child became exceedingly dyspnoëic, and later on in the operation could get no air at all, so that the trachea had to be opened rapidly. Then the picture was at once changed. The air passed much more freely in and out through the tracheal opening, as though a great part of the obstruction had been in the larynx. The larynx was probably somewhat œdematous and much congested. A coughing spell made us notice a yellowish body, which was thrown by the coughing towards the tracheal opening from below. It appeared unexpectedly several times with much mucopurulent secretion. It could, however, not be

caught. We recognized that the body would have come out if the opening had been larger. Though it was of good size, the spreading of the tracheal edges had flattened the opening somewhat. I enlarged it upward and downward, and the next coughing spell made the large, long kernel fly out. Its dimensions were fourteen millimetres by nine millimetres by five millimetres. There is no question but what this kernel had been impacted into the right main bronchus, then began to swell and soften, and then entered the trachea, where it gave a marked dyspnoea for both lungs. As long as we know that a person can breathe freely with only a part of one lung entirely unobstructed, it is not surprising that the difficulty became greater for the child, when the trachea was to a great extent obstructed through this large grain, than when one lung was entirely shut off. The difficulty was even more marked in the forced expiration, when the kernel flew up against the glottis and obstructed this narrow channel like a ball-valve. I do not think that this kernel was thrown against the glottis at every expiration, but only when the child coughed. The difficulty in the inspiration was probably due to a congestion in the glottis, besides a partial obstruction by the kernel at the bifurcation of the trachea. The face of the child appearing congested and somewhat cyanosed, we must conclude that the same congestion due to the dyspnoea was in the glottis. This explains the much freer breathing as soon as the trachea was opened, notwithstanding the kernel of corn was below the opening.

Before cutting the trachea, the difficulty in inspiration was due to two causes,—the one of which was the narrowed glottis, the other the obstructing kernel at the bifurcation of the trachea. The former must have been an important factor, because the breathing and the color of the child changed markedly as soon as the trachea was freely opened. In expiration the large tracheal wound would allow of more air passing by the kernel than the narrow and swollen glottis would.

After the foreign body was removed, the respiration became easy, the cyanosis disappeared, and the breathing

through the larynx became free even when the trachea was allowed to close. The child recovered nicely.

I have been anxious to add this case to my paper, as I find several cases in the literature where the dyspnoea was not enough allowed to command all therapeutic measures. Kredel, for instance, reports a case where a child was erroneously treated for pleurisy, and where suddenly most pronounced expiratory dyspnoea occurred. The inspirations were very short and snappy, while the expirations were labored, long, and whistling. No knowledge existed of a swallowing of a foreign body, and the case remained unoperated. Besides the expiratory dyspnoea, severe acute emphysema of the lungs was observed. The child died within an hour.

Of another case I found a pretty drawing of an autopsy specimen in the "Handbuch der Chirurgie." There you can see a bean impacted in the entrance to the right bronchus. It swelled, protruded gradually more towards the trachea, until finally the other bronchial opening became interfered with. Such cases cannot be too strongly impressed on our mind, and their memory is most useful for other cases of this kind. A detailed observation of the character of the dyspnoea in each case is very important, and the more we have detailed cases of this kind the more will the diagnosis become sharply detailed, and this will be helpful for the steps to be taken in each individual case. All these experiences help to condemn the expectant treatment in doubtful cases, especially since we are better equipped to explore the air-passages.